High-Density Holographic Memory

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ABSTRACT

A new holographic memory (HM) system will be presented. This system utilizes an innovative electro-optic (E-O) beam steering technology to achieve the design goal of storage capacity up to 250 Gbs and transfer rate up to 1 Gbs/sec in a cubic photorefractive crystal.

ADVANCED HOLOGRAPHIC MEMORY WITH AN ANGULAR MULTIPLEXING SCHEME USING LIQUID CRYSTAL BEAM STEERING DEVICES

JPL is currently developing a new HM system with the following performance characteristics: read/rewrite capability, high-density, high transfer rate, non-volatility, compact form, and radiation resistance. These characteristics were selected to meet requirements for data storage needs both for NASA's space missions and for commercial applications.

The holographic memory architecture, as shown in Figure 1, consists of a write module and a readout module. The write module includes a laser diode as the coherent light source; a pair of cascaded beam steering Spatial Light Modulators (BSSLM), one transmissive and one reflective, for angular multiplexed beam steering; a data SLM for data input; two cubic beam splitters for beam forming; and a photorefractive crystal for hologram storage. The readout module comprises a laser diode; a pair of cascaded BSSLMs to generate a phase conjugated readout beam; the shared photorefractive crystal; a cubic beam splitter; and a photodetector array for hologram readout.

The enabling device in the HM breadboard is a BSSLM used for angular beam multiplexing. This BSSLM consists of a 1 x 4096 Nematic Twist Liquid Crystal (NTLC) array built on a VLSI back plane in ceramic PGA carrier. A photo of this BSSLM is shown in Figure 2. This device is capable of providing 128 resolvable holograms in a 1-D scanning scheme. Cascading a pair of these devices will enable a 2-D beam-multiplexing scheme. This 2-D beam multiplexing approach results in a total of 11,520 resolvable scanning angles providing storage for more than 11,000 pages of holographic data in a PR crystal with a volume of 1 cm^3. The storage capacity of this HM system using a 1000 x 1000 pixel input page would exceed 10 Gbs. Further increasing the input page size to 5000 x 5000 pixels would result in a storage capacity of 250 Gbs. Stacking a multiple of such holographic memory cubes on a memory card (e.g. 10 x 10 cubes on each card) will achieve a storage capacity of 1 terabits per card. The transfer rate of this HM system will range from 200 Gbs/sec (using a Nematic liquid crystal BSSLM) to 2000 frames/sec (using a Ferroelectric liquid crystal BSSLM).

We have recently developed a compact holographic memory breadboard according to the architecture depicted in Figure 1. This compact breadboard, shown in Figure 3, is the size of a

telephone book. High-quality grayscale holographic images were successfully recorded and retrieved from this experimental setup.

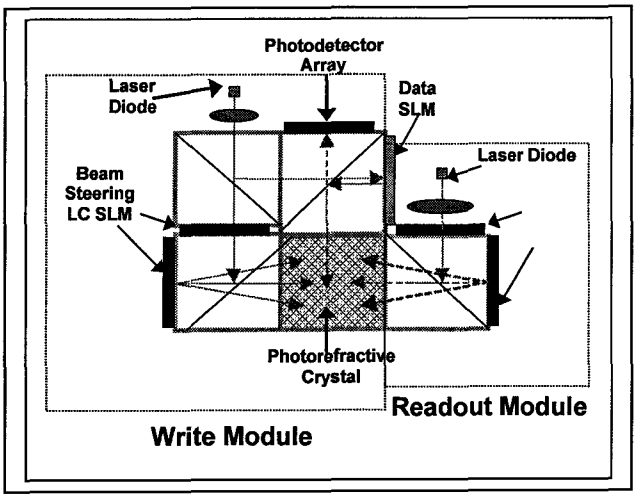

Figure 1. System architecture of an Advanced Holographic Memory

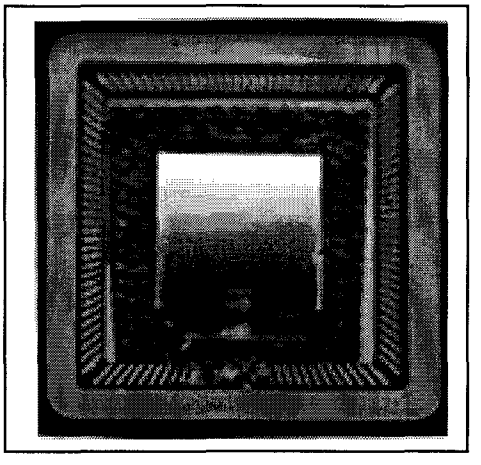

Figure 2. Photograph of a 1 x 4094 Liquid Crystal Beam Steering SLM

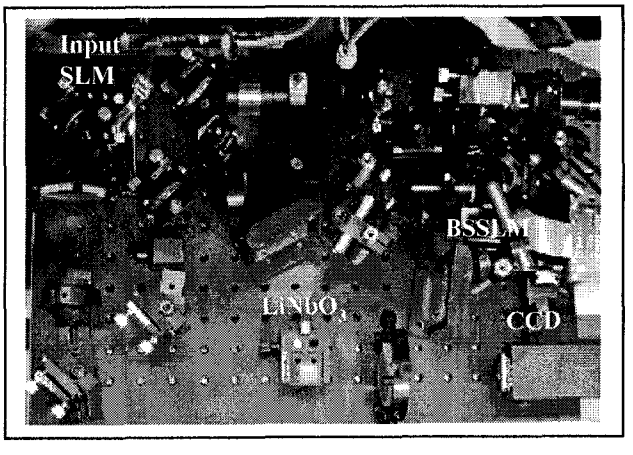

Figure 3. A book-sized holographic breadboard under development at JPL

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REFERENCES

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